Robotic Thymectomy for Thymic Neoplasms

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KEYWORDS

• Thymectomy • Thymoma • Robotic

KEY POINTS

- Robotic thymectomy is a minimally invasive technique for removal of thymic tumors.
- A variety of options exist for access, port placement, and specimen retrieval.
- Favorable short- and long-term safety and efficacy of robotic thymectomy for thymic neoplasms have been well demonstrated.

INTRODUCTION

Thymectomy was first reported for the treatment of myasthenia gravis (MG) in 1939.[1] Although the indications for thymectomy—MG and thymoma—have not changed, the surgical technique has evolved significantly. The historical access via a median sternotomy has given way to more minimally invasive techniques, including the transcervical and thoracoscopic approaches.[2] Videoscopic thymectomy can be further enhanced with the aid of a surgical robot. This article provides an overview of the indications, technique, and outcomes of robotic thymectomy for the treatment of thymic masses.

Thymic masses vary in size, gross and microscopic invasion, and histology. They are classified according to the Masaoka-Koga and World Health Organization classification schemes.[3–5] Size is generally accepted as a determinant of operative approach, although no universal guidelines exist. In general, most surgeons agree that lesions 3 cm or less are amenable to minimally invasive approaches because of visualization reasons and the ability to remove them through the small port sites. Case reports have published involving larger tumors, but long-term follow-up on locoregional control and oncologic efficacy are lacking. It is advisable that surgeons who are just beginning to perform a robotic approach to mediastinal tumors should start with smaller tumors.

Several operative approaches for thymectomy have been described.[6] Traditional thymectomy is performed via a transsternal approach with division of the sternum; however, this approach is accompanied by significant morbidity in 4% to 22% of cases.[7] Additionally, patients with symptomatic MG often have impairment in respiratory function at baseline and inhibition in wound healing because of immunosuppressive medications. For these reasons, minimally invasive approaches to thymectomy have been developed.

Established minimally invasive surgical approaches include transcervical[8] and transthoracic videoscopic thymectomy.[9] These approaches offer radical resection of the thymus with potentially lower morbidity and shorter length of hospital stay compared with open surgical resection via sternotomy. Transcervical thymectomy is limited by size and patients are still at risk for pneumothorax and vascular injuries despite the cervical approach.[10] Some authors propose a combined transcervical and transthoracic approach to ensure completeness of resection.[11]

The thoracoscopic approach can be further optimized with the aid of the da Vinci robotic surgical system (Intuitive Surgical, Mountain View, CA, USA). Robotic-assisted surgery has been

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shown to be safe and feasible in a variety of cardiac, otolaryngologic, gynecologic, and abdominal surgical procedures. The application to thoracic surgery is intuitive, wherein precision of dissection is mandatory but the working space is small and limited by the rigid confines of the chest wall. Resection of anterior mediastinal masses, specifically thymectomy, is an ideal operation to be performed thoracoscopically with the aid of the da Vinci robot. Precision of dissection is mandatory not only because of the vital nature of the structures being dissected but also to avoid overmanipulation of a thymic mass and potential seeding of the mediastinum.

Robotic thymomectomy was first described in 2001,[12] and description of a complete thymectomy using a robotic thoracoscopic approach soon followed in 2003.[13,14] To date, several moderate-sized retrospective series review the international experience with this procedure for MG and thymic malignancies.[15–23] Several different techniques have been described for robotic thymectomies and vary according to different parts of the operation. These components are listed in (**Box 1**).

SURGICAL TECHNIQUE

Preoperative Planning

Patients referred for thymectomy have generally already undergone imaging with either computed tomography (CT) scan or magnetic resonance imaging (MRI). Radiographic characteristics that must be assessed include size, heterogeneity, and presence of infiltration of adjacent structures. Intravenous contrast for the CT scan via the left arm is useful in identifying the proximity of the tumor to the innominate and superior vena cava, and the great vessels. Although no specific size limit exists for performing robotic/video-assisted thoracoscopic surgery (VATS) versus open resection, tumors greater than 3 cm should be approached by experienced robotic surgeons. Moreover, while invasion of adjacent structures, such as the pericardium or lung does not preclude a minimally invasive approach, these cases should be chosen carefully in order to maintain oncologic efficacy first and foremost.

Box 1
Components of robotic thymectomies

- Single lung isolation versus carbon dioxide (CO_2) insufflation
- Patient positioning and padding
- Robot console/monitor/arm placement
- Right versus left side approach
- Length, placement, and number of surgical incisions
- Bilateral approach
- Extent of resection
- Optional neck incision

Preparation and Patient Positioning

An epidural catheter is placed preoperatively for postoperative pain control. General endotracheal anesthesia is induced. Double-lumen intubation with bronchoscopic confirmation is performed; alternatively, some surgeons prefer insufflations of the hemithorax with CO_2 rather than endotracheal lung isolation. If both pleura are used for dissection, then separate lung isolation would be ideal. Radial arterial line monitoring, large-bore venous access, urinary catheterization, and sequential compression devices are institution-dependent. The patient is placed supine with both arms tucked, slightly flexing the right arm to allow more access to the lateral chest. Padding is carefully placed to avoid any pressure points on the face, arms, and legs. The operating table is rotated leftward for a shoulder axis of 30° to the horizontal. The patient is prepared and draped in standard fashion, exposing the entire sternum and chest wall. Hybrid modifications have been added that require access to the contralateral chest.

Surgical Approach

The initial transthoracic approach reported was generally bilateral to ensure complete resection and visualization of the bilateral phrenic nerves.[2] Although bilateral access is still preferred by some surgeons, others maintain that a left-sided approach is superior because of the size differential of the left versus right inferior horn, and proponents of a right-sided approach prefer the additional working space. If the contralateral phrenic nerve is incompletely visualized or aberrant thymic tissue is suspected, bilateral access is mandatory to ensure a radical resection. In the presence of a dominant mass, the ipsilateral side is favored. If neither side is indicated by presence of an ipsilateral mass, the authors favor, an initial unilateral right-sided approach because of the increased working space.[2]

General Preparation

After satisfactory induction of general anesthesia, a double-lumen endotracheal tube or bronchial blocker is correctly placed and positioned. A shoulder roll is placed, and both arms carefully tucked and protected at the patient's sides. Just in case a sternotomy or upper sternal split is

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